Air Force Office of Scientific Research Overview

USAF/Taiwan Nanoscience Initiative Workshop – Honolulu, HI

Dr. Brendan B. Godfrey

Director

brendan.godfrey@afosr.af.mil

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
06 DEC 2005	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Air Force Office of Scientific Research Overview	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air Force Office of Scientific Research 875 N. Randolph St., Suite 325, Arlington, VA 22203-1768**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM201995., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**24**	

AFOSR Mission

AFOSR Orchestrates the Air Force Basic Research Program with Universities, Industry, Other Government Organizations, and the AFRL Technical Directorates (TDs)

Creating Revolutionary Scientific Breakthroughs for the Air Force

Major AFOSR Activities

- Encourage and Support Basic Research Supporting AF Needs
  - Air Force Basic Research Grants and Contracts
  - Multidisciplinary University Research Initiatives
  - Defense University Research Instrumentation Program
  - DARPA and Other Agency Funds
- Identify and Disseminate Basic Research Discoveries
- Educate Tomorrow's S&Es (DOD Education Programs)
  - National Defense Scientists & Engineers Fellowships
  - Undergraduate Scholarships
- Leverage Foreign Research
  - Liaison Offices in Europe and Asia
  - Window on Science – 335 Visitors in FY04
  - Personnel Exchanges

AFOSR Orchestrates the Air Force Basic Research Program with Universities, Industry, Other Government Organizations, and the AFRL Technical Directorates

AFOSR Funding Profile
(FY04)

~ 5000 Researchers

AFOSR Ballston

Air Force 6.1 Funding

$204M

~30%

AFRL Technology Directorates
240 Projects

~60%

187 Universities
809 Grants

~10%

Other
185 Contracts

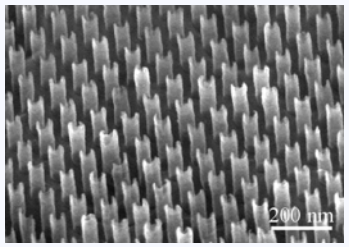
As of 1 Sep 04

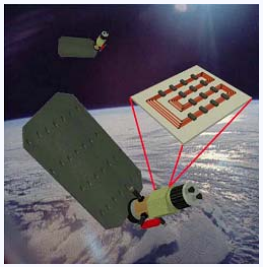
Recent Scientific Breakthroughs Supported by AFOSR

- **Spintronics:** Studying electron spin coherence, ultrafast electronic spin polarizers, and electronic spin manipulation • Implications for all aspects of information processing technology
- **Left-Handed Materials:** Developing magnetic composites negative indices of refraction • Wide range of potential applications (antenna, microwave devices, shielding)
- **Electromagnetics:** Studying the propagation of modulated EM radiation by dispersive media • Potential new strategy to reveal hidden targets
- **Polynitrogen Chemistry:** Computational methods used to aid synthesis of new all-nitrogen compounds • First new all-nitrogen species, N_5^+, in over 100 years • Studying reactivity and compatibility of compounds
- **Biomimetics:** Examining morphology and physiology associated with infrared detection in pit vipers and pythons • Potential room-temperature IR detection
- **Nanotechnology:** Investigating novel phenomena, properties and functions that occur on the nanoscale • Invention of dip-pen nanolithography

FY06 POM Initiatives Support AFRL Nanotechnology Initiative

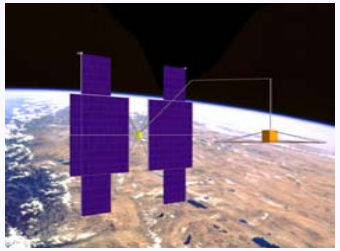
Nanoelectronics: Multispectral Detector Arrays: Explore techniques to control growth of self-assembled quantum structures, connections to the structures, and combinations of both, which will lead to detectors for multispectral and hyperspectral image processing.

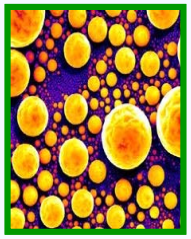




Nanoelectronics: Chip Scale Optical Networks: Forward-looking architectural effort that seeks to develop new concepts in the design, operation, employment, and overall functioning of military platform networks.

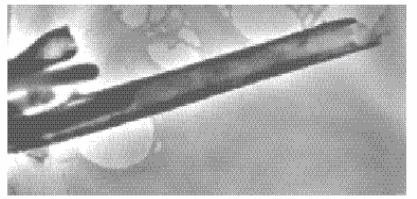
Nanoelectronics: Compact Power for Space: Increase specific power for solar arrays, fuel cells, and power storage systems for high power space platforms.





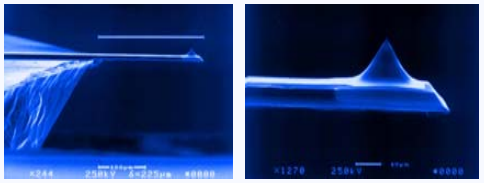
Nanoenergetics: Enable the development of higher performance, less-sensitive nanoscale energetic materials for applications in munitions and propulsion.

Nanomaterials for Structures: Establish nanomaterial and nanocomposite systems that will enable reduced system weight or size, increased operational lifetime, and multifunctional performance of load-bearing aerospace structures.

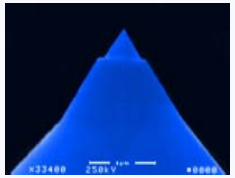


Overview of AFRL Nanoscience and Nanotechnology Interest

- Materials Area
  - Tailorable Dielectrics
  - Reconfigurable Optical Response
  - Adaptive Structural Materials
  - Thermal Control Materials
- Energy Area
  - Energetics on the Nanoscale
  - Nano-enhanced Power Technologies
- Devices Area
  - Quantum Confined Optical Sensors
  - Nanotechnology for RF
  - Nano Signal Processors
- Bio-Nano Area
  - Bio Interactions of Nanostructures
- Cross-Cutting (foundations)
  - Self-assembly of Nanostructures
  - Nano-Micro-Macro Interfaces
  - Modeling And Simulation



Nanoprobes



Taiwan – AFOSR Nanoscience Initiative

- Natural extension of common interest
- Founded in recognition of Taiwan's commitment to establishing itself as a world-class technical power in nanoscience and nanotechnology
- Primary goal: To establish mutually beneficial scientific interactions between researchers in Taiwan and AFRL scientists
  - Foster basic research innovation & interactions between scientists
  - Enhance future USAF capabilities through support of Air Force fundamental nanoscience research efforts

Taiwan Participants Include

- National Science Council
- Academia Sinica
- Industrial Technology Research Institute
- Chung-Shan Institute of Science and Technology
- National Central University
- National Cheng Kung University
- National Chiao Tung University
- National Chung Cheng University
- National Taiwan Normal University
- National Taiwan University
- National Tsing Hua University

Nanoscience Initiative Summary

- 24 projects total completed / funded / approved
- More than 70 white papers received over life of the program
- 19 visits + 20 proposed visits by Taiwanese researchers to AFRL scientists
- 5 visits by AFOSR to Taiwan
- 3 joint workshops

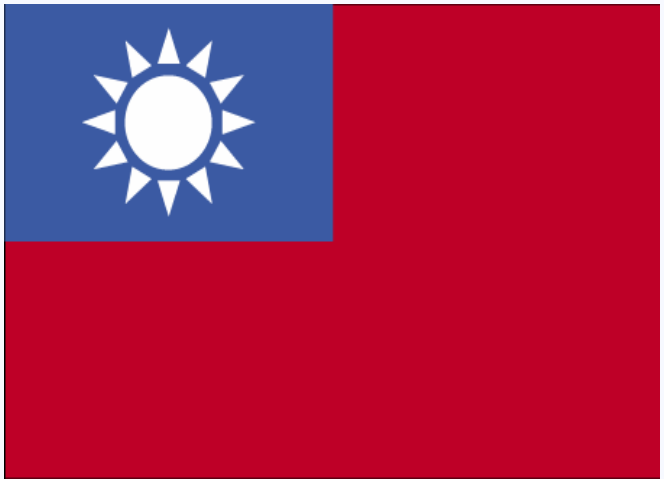
Taiwan – AFOSR Nanoscience Initiative is delivering many opportunities for interactions between Taiwan and Air Force Research Laboratory researchers

- Pay-off
  - Relationships established between US & Taiwan researchers
  - Cost effective enhancement of USAF basic research efforts
  - Acquisition of unique basic nanoscience research results

NTU Researchers w/ AFOSR personnel

Closing Thoughts – Win-Win Future

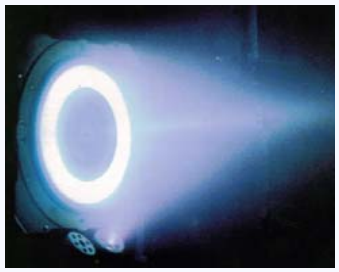
- **Nanoscience and nanotechnology Information Exchange Agreement approaching final approval**
- **Congratulations to Dr. Maw-Kuen Wu for his appointment to Director, National Science Council**
- **AFOSR initiatives with Taiwan foster and generate goodwill**
- **Further the scientific goals of the United States and Taiwan**

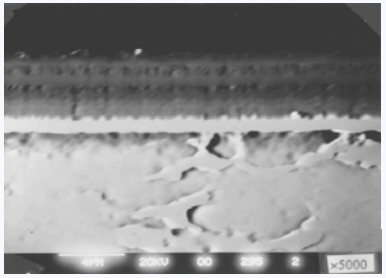


Backup

EOARD Highlights

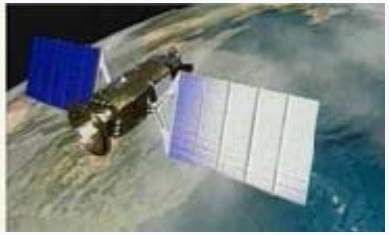
- Hypersonics: Russia
  - Leveraging Russian Expertise (Bow Shock Control, Boundary Layer Control, Plasma Fuel Injection, Heat Flux Control, etc.)
  - Technology is Transitioning
- Hall Effect Thruster (HET): Russia, Spain
  - HETs Provide Highly Efficient Spacecraft Propulsion (Increased Payload/Decreased Cost)
  - Investigating How to Cluster Multiple HETs for Increased Power
- Damping Coatings: Ukraine
  - Seeking to Overcome High Cycle Fatigue Effects on Titanium in Air Force Fighter Engines
  - Investigating Layering Materials on Titanium to Improve Damping



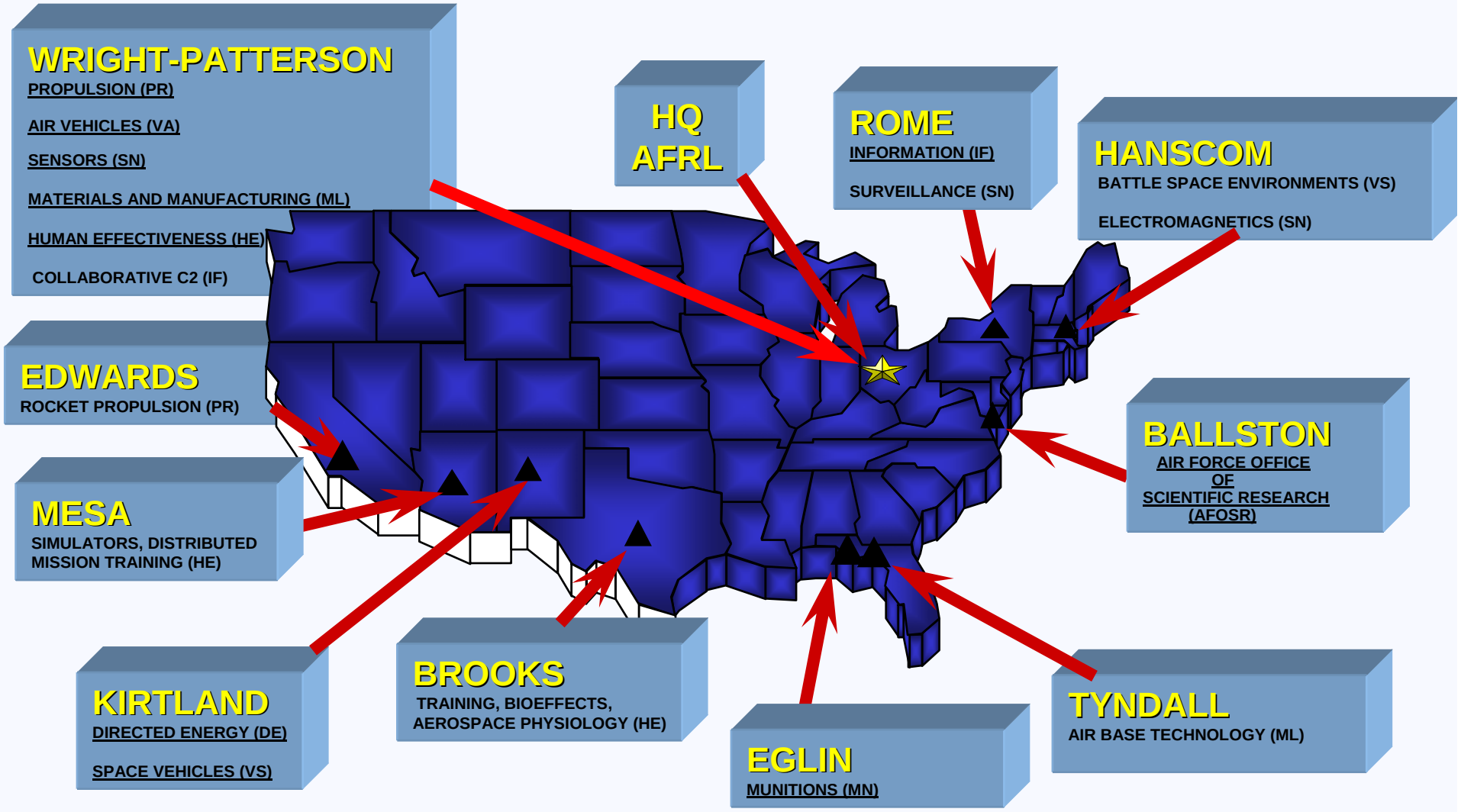


AOARD Highlights

- Nanoscience Initiatives: Taiwan & Korea
  - Leveraging Asia's $1 Billion Nano-science Investment
  - Research Areas Include: Quantum Dots, Polymer Electronics, and Photovoltaics
- Ionospheric Scintillation Data: Taiwan
  - Studying Low-latitude Events that Can Interfere with Communications
- Micro-turbine Research: Japan
  - Developing Lunch-box Size 100 Watt Power Sources, 10 mm Rotors, High-speed Bearing Technology (1 Million RPM)
- Hyshot In-flight Scramjet Test: Australia
  - Leveraged Data from 1st In-flight Supersonic Scramjet Combustor Test (Mach 7.5)
  - Initiating Future Collaborative Efforts



AFRL Major Sites and Technology Areas



AFOSR Organization

DIRECTOR
Dr. Brendan Godfrey

DEPUTY DIRECTOR
Col (S) Jeff Turcotte

CHIEF SCIENTIST
Dr. Herb Carlson (ST)

PHYSICS & ELECTRONICS

Dr. Jack Agee
Director

AEROSPACE & MATERIALS SCIENCES

Dr. Walter Jones
Director

CHEMISTRY & LIFE SCIENCES

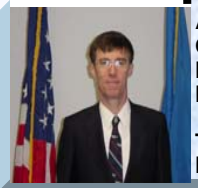
Dr. Genevieve Haddad
Director

MATH & SPACE SCIENCES

Dr. Clifford Rhoades
Director

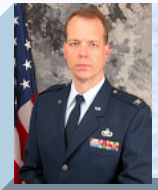
INTERNATIONAL OFFICE (IO)

Dr. Mark Maurice



ASIAN OFFICE OF AEROSPACE RESEARCH & DEV

TOKYO
Dr. Terry Lyons

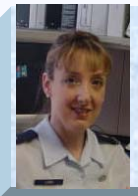


EUROPEAN OFFICE OF AEROSPACE RESEARCH & DEV

LONDON
Col William McClure

RESOURCE MANAGEMENT

Ms Terry Hodges



STAFF JUDGE ADVOCATE

Maj Vicki Lund

DIRECTORATE OF POLICY & INTEGRATION

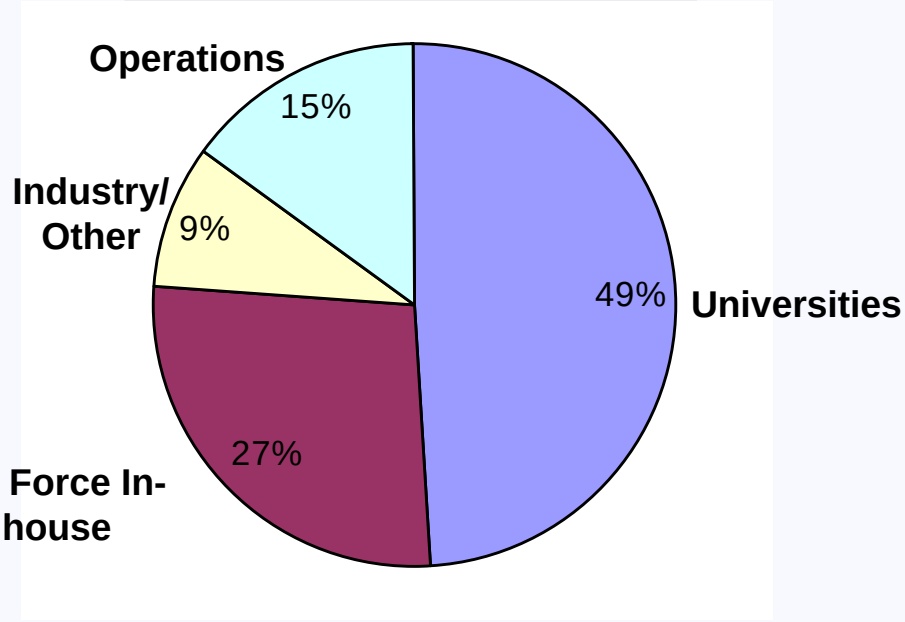
Col Thurmon Deloney

DIRECTORATE OF CONTRACTING

Ms Kathleen Miller

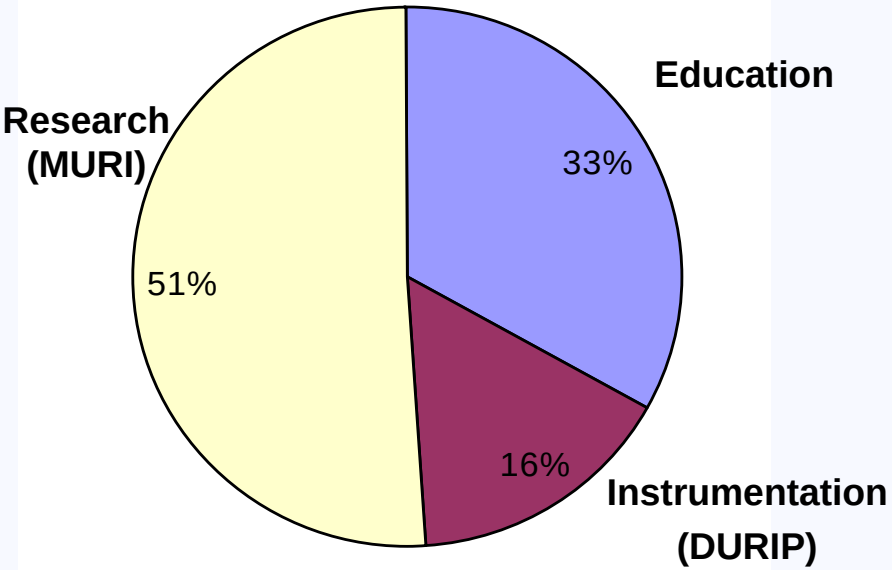
AFOSR FY2004 Budget Authority

PE 61102F
Defense Research Sciences



$205M

PE 61103F
University Research Initiatives (URI)



$104M

AFOSR also Executes ~$85M for Other Organizations and Programs (STTR, DARPA, etc.)

AFOSR Supports Tomorrow's Scientists and Engineers

- **Research Grants to Universities**
  - 3000-4000 Graduate Students and Postdocs
- **National Defense Science and Engineering Graduate (NDSEG) Fellowships**
  - 452 PhD-track Graduate Students
- **Awards to Stimulate and Support Undergraduate Research Experience (ASSURE)**
  - 480 Undergraduate Students
- **Junior Science and Humanity Symposium (JSHS)**
  - 50 Scholarships for Regional and Final High School Student Winners
- **National Research Council Resident Research Associateships**
  - 25 Postdocs Working in AFRL

Aerospace and Materials Science

Technology Foci	Relevant Capability
• High Cycle Fatigue	• Reduce engine fatigue
• Smart Skins/Adaptive Wings	• Increase Lift/Drag ratio
• Structural Mechanics	• Reduce aerospace vehicle weight
• Metallic Materials	• Increase engine thrust to weight ratio
• Ceramic and Non-Metallic Materials	• Eliminate materials reliability issues
• Organic Matrix Composites	• Expand flight envelope and enhance maneuverability
• Unsteady Aerodynamics	• Minimize events of engine stall
• Turbulence and Rotating Flows	
• Space Power and Propulsion	• Reduce hypersonic drag
• Combustion and Diagnostics	• Provide low cost, more flexible space access
	• Streamline aircraft and rocket propulsion system design

Physics and Electronics

Technology Foci	Relevant Capability
• Lasers and Optical Physics	• Processing speeds orders of magnitude faster than today
• Atomic and Molecular Physics	• Recovery of images through atmospheric turbulence
• Plasma Physics	• Greater radiation tolerance
• Space Electronics, Sensors and Propulsion	• 1000 times improvement in data storage
• Optoelectronic Information Processing	• Expanded transmission bandwidth
• Semiconductor Materials	• Real-time adaptive signal and image processing
• High Power Microwaves	• Electronic warfare and non-lethal effects

Chemistry and Life Sciences

Technology Foci	Relevant Capability
• All-Nitrogen Propellants	• Energetic materials for propellants and explosives
• Theoretical Chemistry	• Ten times more powerful chemical lasers
• Polymer Chemistry	• New polymer materials
• Biomimetic Sensors	• Biomimetically enhanced sensors
• Chronobiology and Neural Adaptation	• Strategies to reduce fatigue
• Information Fusion	• Command & control decision making
• Perception and Cognition	• Better personnel training, selection, and classification
• Switchable, Tunable Optical Filters	• Versatile laser protection
• Adaptive Bio-Materials	• New class of highly functional light weight polymeric materials

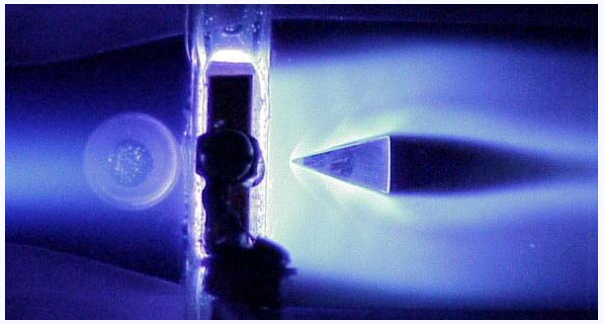
Mathematics and Space Sciences

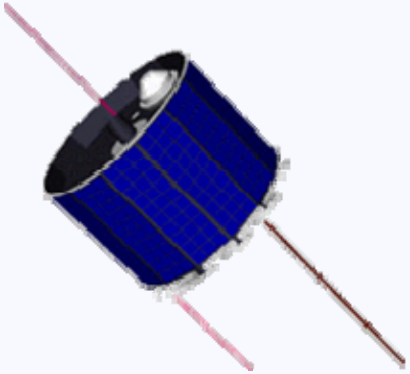
Technology Foci	Relevant Capability
• Dynamics and Control	• Modeling of complex problems and systems
• Physical Mathematics and Applied Analysis	• Control of vibrations and shape of space structures
• Computational Mathematics	• Better vehicle performance and control
• Optimization and Discrete Mathematics	• New methods for target acquisition and recognition
• Systems, Software, and Reliability	• Detection avoidance
• Artificial Intelligence	• Timely management of information
• Electromagnetics	• Improved solar and space environment forecasting
• Space Physics and Solar Phenomena	• Protection of space assets
• Spectral Imaging	• ID Targets Under Trees
• Upper Atmosphere Laser Beam Propagation	• ABL targeting through turbulence

AFOSR Themes

Cooperative Control: Develop fundamental theory, algorithms, and software to design and analyze robust, high-performance, team-based, multi-agent cooperative control systems operating in dynamic, uncertain adversarial environments

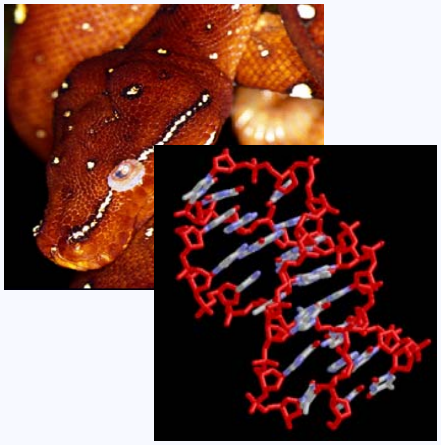
Plasma Dynamics: Understand, predict, and control weakly ionized flows to revolutionize the performance of aerospace vehicles





Miniaturization Science for Space: Enable much lighter, more compact, microsatellites, nanosatellites & picosatellites

AFOSR Themes



Biologically Inspired Concepts: Provide biologically inspired technology by exploring living systems down to molecular level
• Develop chemical models & engineering concepts

Type II Quantum Computation: Develop near-term quantum computer implementations • Develop algorithms to model physical systems • Explore architectures to scale a large array of small quantum computers

Materials Engineering Exploit computational materials science and engineering to develop techniques for coupling models of material behavior • Enable materials design to be an integral part of the global design process